OHIO BRASS MANAGEMENT REPORT

Why we believe in one-color rainbows in '65

BY ROGER A. BLACK
PRESIDENT, OHIO BRASS COMPANY

What could have become a serious problem now seems well on the route to solution thanks to decisive action by the Transmission & Distribution Committee of EEI. Also contributing to the constructive solution are important user groups such as Southeastern Electric Exchange.

AS YOU PROBABLY KNOW, the EEI committee has recommended Munsell No. 5 BG 7.0/0.4 as the standard color for insulators and other overhead materials. Acting for the manufacturers, NEMA has instructed its representative to ASA to vote for the new EEI color as a standard color in Code Z-55.1 covering American standard gray finishes for industrial apparatus and equipment. At Ohio Brass we will soon offer many products in Munsell 5 BG 7.0/0.4 and hope it gains widespread acceptance among our customers.

THUS WE CAN ANTICIPATE an end to the nightmare that plagued the dreams of manufacturers in recent months — a nightmare that had every utility asking for a special color. As the colors multiplied into hundreds of shades and hues, we shuddered at the chaos that would result in the planning and cost of manufacture. All the colors in the dream made a beautiful rainbow, but this time we wished the rainbow were all one color.

MUNSELL NO.
5 BG
7.0 / 0.4

ALSO CONTRIBUTING IMPORTANTLY to the clarification and definition of the new color was the system established by Albert Henry Munsell, an American portrait painter who died in 1918, long before we began worrying about insulator colors. Mr. Munsell measured three dimensions of color — hue, value, and chroma. He made it possible to express any particular color in precise terms and to differentiate it from other colors in the same general class.

THUS IN THE EEI recommendation for Munsell No. 5 BG 7.0/0.4, the first number (5) represents the hue of blue-green (BG), with hue being the quality to distinguish one color from another — green, blue, yellow. The second number (7.0) is the value, with value being the quality by which we distinguish a light color from a dark one; and (0.4) stands for chroma, or the strength of the color.

SO WE HAVE ARRIVED, or almost arrived, at Munsell No. 5 BG 7.0/0.4 . . . thanks to EEI, NEMA and Mr. Munsell's system.

738-H

OHIO BRASS COMPANY • MANSFIELD, OHIO
Canadian Ohio Brass Co. Ltd. • Niagara Falls, Ontario

OHIO BRASS

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HI-TENSION NEWS

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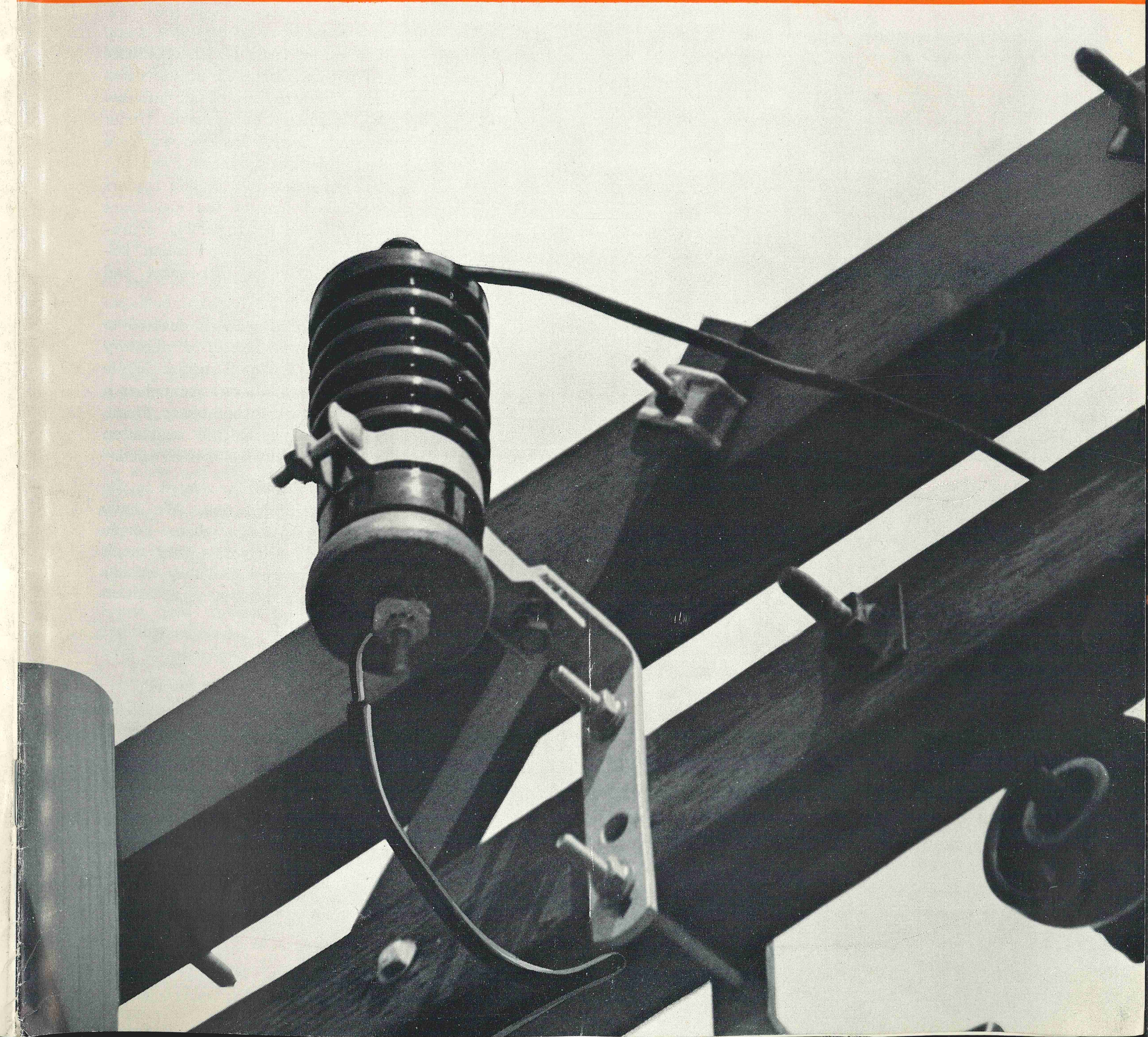
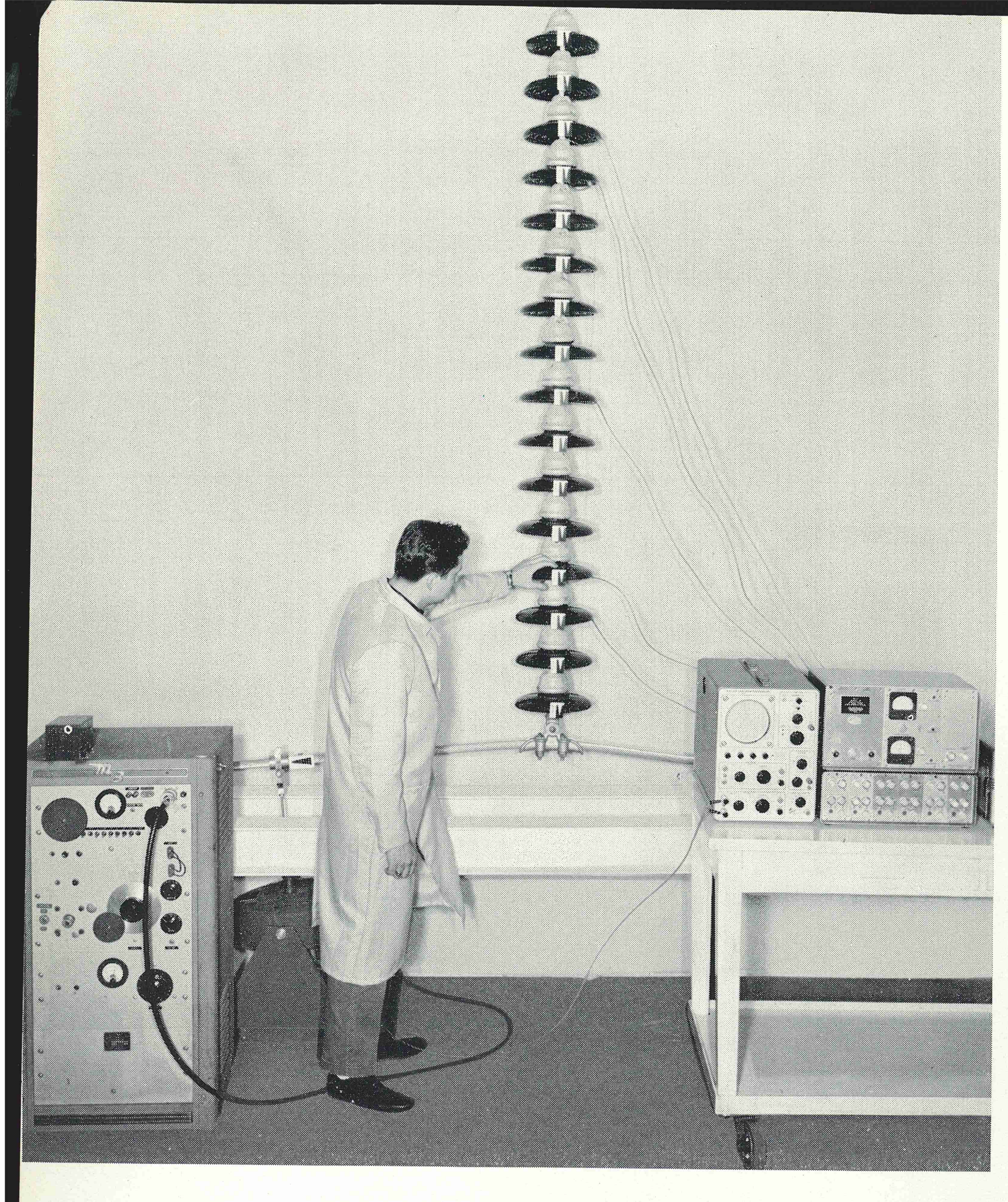
Distribution lightning arrester "Buyer's Guide" (pages 11, 12, 13) reviews Multirester advantages.





Clevis-type insulators inherently immune to damage from conductor vibration

In a recent issue of HI-TENSION NEWS we discussed a few comments from readers of our publication "Insulator Performance Under Dynamic Duty." Perhaps we were slow in detecting a major trend, but it now appears that certain readers overlooked one of the significant points in the book; namely, a profound difference in vibration behavior between ball-socket and clevis insulators.

Considerable space is devoted to the causes and effects of vibratory damage to insulator strings. While this was certainly not painted as a hopeless or unpreventable condition, the need for realistic evaluation and effective control was stressed.

All this discussion related to the ball-socket connection. We have encountered cases where people have taken our words very much to heart (as we hoped they would) and have asked for our consultation in new applications. Then it later developed that these questions were directed at clevis-type insulators, and their concern was unjustified.

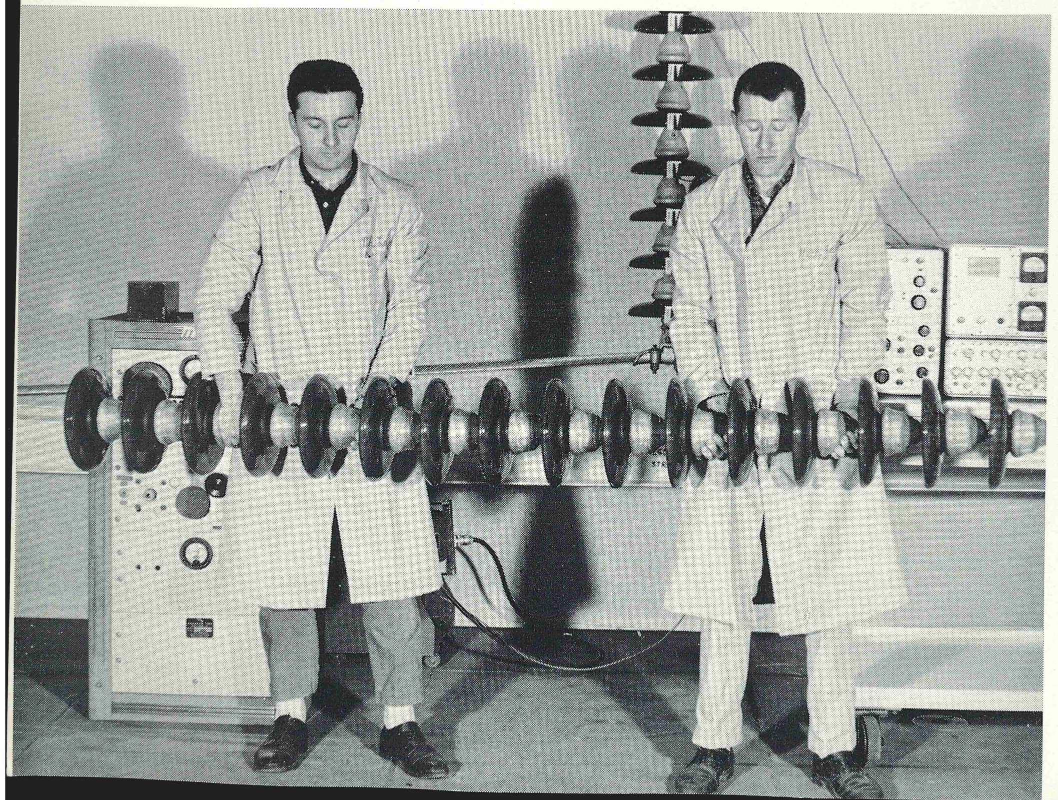
Clevis connections are not subject to vibratory attack. There is no bending of the insulator pin; therefore, no excessive stress on this member. The small angular displacement between units in the string is harmlessly taken up in the series of flexible joints.

It was pointed out in the book that a string of ball-socket insulators, only slightly loaded, behaves under vibration as a rigid member. Flexibility usually assumed in a ball-socket joint is not present under load. Therefore, inter-unit motion, as the string goes into a vibrating wave, is imposed on the individual pins as a bending stress and, when improperly controlled, can go to the point of fatigue.

Clevis connections, on the contrary, retain inter-unit flexibility under load. This system responds to the vibrating wave in a normally expected fashion, and no damaging stresses build up in metal components of the insulator.

Long spans and heavy conductors, typical of EHV lines, tend to produce higher tensions that make the conductor member susceptible to aeolian vibration. This condition can be made tolerable to properly designed ball-socket insulators through various means recommended by conductor manufacturers. Many utilities, however, have taken another route to protecting their insulation by specifying the clevis type. This design is showing a rapidly increasing popularity in EHV construction.

While the foregoing points were discussed in the book "Insulator Performance Under Dynamic Duty," the fact that this book was written from a non-commercial viewpoint may have resulted in a lack of proper emphasis. Now, if we may be frankly commercial for a moment, we would recommend serious consideration of clevis-type connections in specifying insulators for a new EHV system.



All inter-unit joints in this ball-socket insulator string were solidly welded. It was then put on vibration test and went into resonance at the same frequency and amplitude and produced the same pin bending stress, as a conventional string. This proves that, under the action of conductor vibration, ball-socket insulators even moderately loaded lock up and behave as a rigid member. Movement at joints caused by vibration, therefore, is supplied by flexing of the pins which can lead to metal fatigue.

"Pack'em so they get here in one piece . . ."

Our headline represents the venerable phrase uttered so often by purchasing agents in the past. Today this comment might be amended several ways, even to this extreme: "Package them in quantities of six, palletized in combinations of 12 complete packages, and in a corrugated carton that will withstand prolonged outdoor exposure." Quite a change isn't it?

We used to ship every order of insulators, hardware, arresters, and other O-B products in containers that would withstand hurricane Dora and a few of her predecessors. Customers didn't worry about package weight and size because they had the labor and time to handle it. Now shipping and handling costs have gone up and efficiency is the watchword. That's why O-B's packaging people considered your needs when they set up standard product packages. You need a package that fits your handling methods, stores conveniently in your warehouse area, and is labeled for quick identification by your personnel.

O-B's standard packages evolved from experience -- yours and ours -- with handling and storing products. Our packaging designers conducted extensive customer research to find the prevailing storage and handling methods, then designed packages to fit them.

Standardization results in several benefits for O-B and its customers. First, standardization keeps packaging operations simple in our factory, permitting O-B personnel to know automatically what package to use and how to pack each product for safe shipment. This saves time and confusion for O-B, and gets O-B products out the door and on their way to you faster. Also, you get a package designed for the product which remains consistent with every order; your personnel grow familiar with the package and know how to store and handle it.

Naturally, packaging problems arise which prove peculiar to a particular area. For one order of pin-type insulators, O-B sent the standard treated corrugated carton which had proved adequate on previous shipments to this customer. One afternoon shortly after shipment, our order service engineer received a frantic call from the customer complaining about cartons "falling apart." Putting out tracers at both ends, these two perplexed gentlemen sought the reason behind the carton failure. Everything checked out OK at O-B's end, and a second call from the customer solved the problem. Line crew personnel had deposited the cartons in stacks along the right-of-way so they could select packages as needed. Meanwhile, the local dairy herds found the sealing glue so palatable they licked all they could off the conveniently stacked boxes. The solution? -- wooden crates with less tasty nails for sealant.

Standard packages offer flexibility to meet your needs. To select one example -- suspension insulators are generally packaged in combinations of four, five, six, or seven units per package. Choose the combination that connects conveniently into your required string lengths and you have a package that can be handled at your construction site by one man -- weighing less than 100 pounds per package. O-B's suspension insulator package consists of a special hexagonal, hard-

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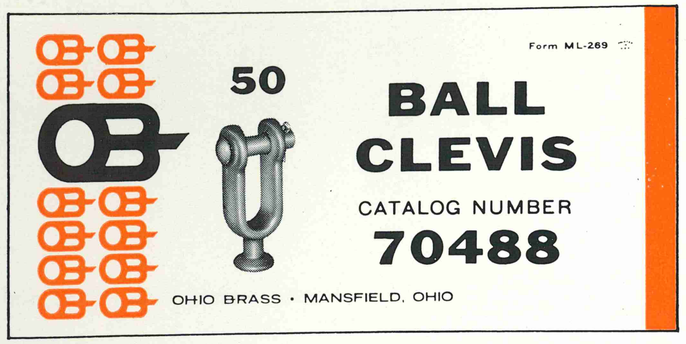
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BALL CLEVIS

CATALOG NUMBER

70488

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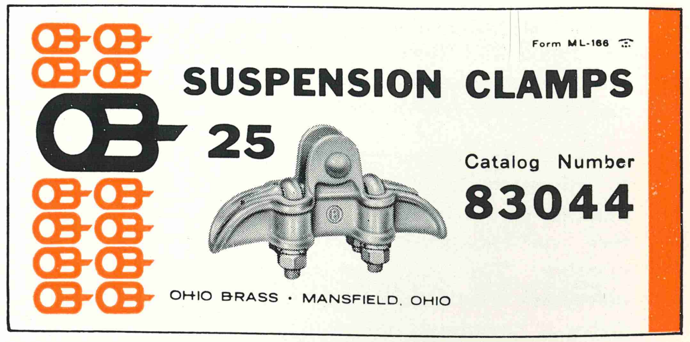

Form ML-166

SUSPENSION CLAMPS

25

Catalog Number

83044

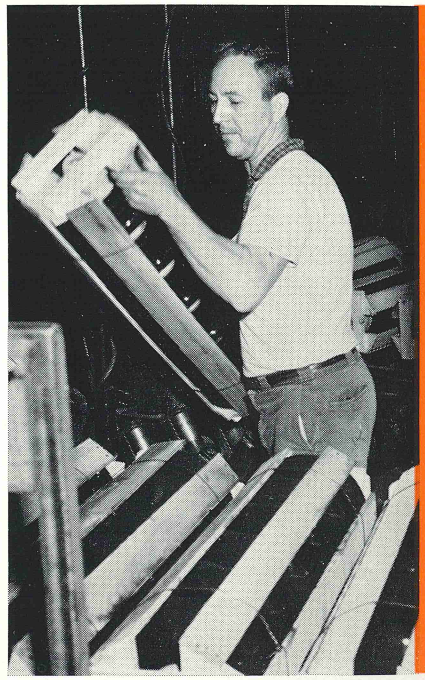
OHIO BRASS • MANSFIELD, OHIO

wood slat crate that stacks well and withstands bumps, shocks, and prolonged exposure. Each package is labeled and stenciled with product catalog number for easy identification. The open-section crates permit quick and easy inspection for shipping damage.

Hardware packaging is different. Most O-B hardware components for distribution voltages are packed in corrugated cartons. (If you have cow trouble, we can use wooden crates.) Transmission hardware is generally packed in wooden crates. Quantities per package are determined by package size and weight, with standard package quantities listed in the "Quantity per Package" column of O-B's Transmission and Distribution Hardware Catalog 44. For several of the new EHV transmission systems where individual quantities were high, O-B met special packaging requirements by packing hardware assemblies in quantities to permit delivery of two or more complete packages to each tower. This aided line personnel in delivering a standard number and type of packages per tower on these giant projects.

Labels add another important consideration to the packaging designer's problem. O-B package labels are large, bright colored, clear in description, and have a product illustration. These assets assure quick, positive identification by line personnel.

Next time you encounter a packaging or storage problem, discuss it with your O-B district manager. O-B's standard package will probably fit your needs and enable us to get your order shipped sooner.



O-B labels each package for quick identification by your personnel. Each label shows an illustration of the product and lists catalog number, quantity per package, and product name.

Standard packages for O-B suspension insulators let you select the combination which will most conveniently make up your string length. Limiting these combinations to four, five, six, or seven units per crate keeps package weight under 100 pounds for convenient manual handling.

Special hexagonal, hardwood slat crates furnish protection for suspension units to withstand bumps, shocks, and prolonged exposure. The open-section crates permit easy and immediate inspection for shipping damage. The consistent shape of the hexagonal crates aids stacking in your storage area or warehouse.

GraybaR QUALITY SINCE 1869 Distributed by GraybaR ELECTRIC COMPANY

Taking the pulse on posts

Ultrasonic test by O-B checks solid-porcelain line-post insulators for defects

Every distribution line post Ohio Brass manufactures gets a special proof test during manufacture. The purpose is to double-check the integrity or homogeneity of the porcelain in the body of each insulator before final assembly and shipment.

Under electrical test, flaws and defects in the porcelain may not show up. But an ultrasonic check on the porcelain can reveal voids or discontinuity of the material which may lessen the strength of the unit and ultimately cause mechanical or electrical breakdown.

O-B inspection and quality control personnel studied many instruments and methods before they selected an ultrasonic technique which employs a pulsed echo-ranging system.

A piece is tested by short bursts of ultrasonic-vibrational waves introduced into the porcelain. The vibrational waves travel in a straight line through the material. If a void or discontinuity is encountered, it constitutes what is called an acoustic-impedance mismatch.

This can locate a fault by reflecting back part of the wave toward the source. This reflected energy is converted into electrical impulses, and the time the shortstopped wave takes to travel through the porcelain is measured. The time interval is proportional to the distance from the entrant surface.

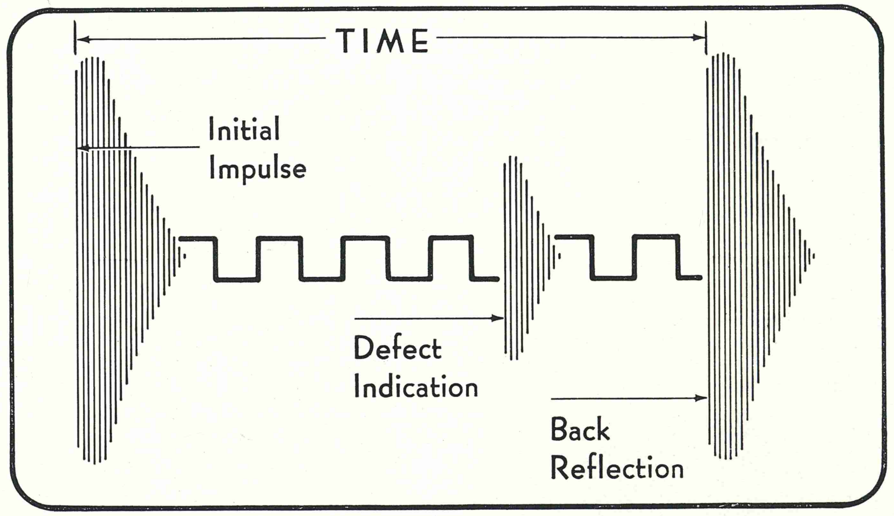
Energy will *also* be returned from the opposite surface of the material by the portion of the wave that does not encounter a fault. This signal is used as a reference for the *total* distance or length of the piece. A cathode-ray tube is used to display the information, and range markers are provided for precise measurement of distance.

Under normal conditions, the electronic beam reveals an initial pulse, or blip, followed by full square waves until they reach the end of the porcelain piece. This causes back deflection, represented by a blip identical to the first one. The porcelain checks out OK!

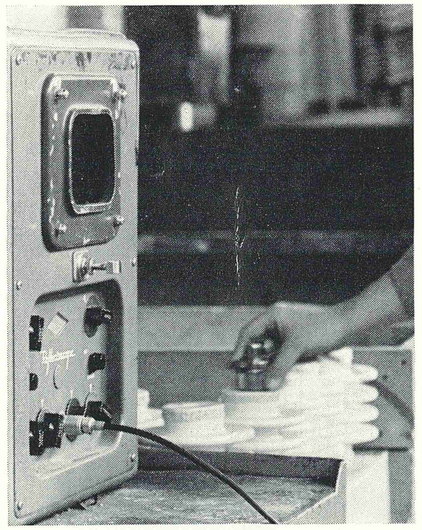
If, and when, a defect is encountered, a small blip shows up in the full-square-wave area -- between the two identical, larger pulses. The piece is scrapped.

The operator of the ultrasonic test machine must stay on his toes, because these defects do not come very often. O-B's porcelain has many checks, during manufacturing, against such discontinuities.

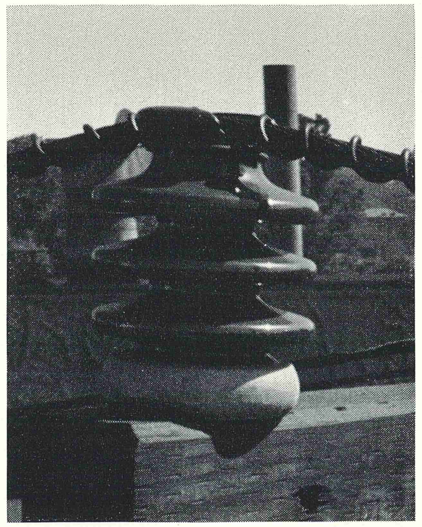
O-B solid line posts -- vertical and horizontal, clamptop and tie top -- enjoy an excellent record for service on distribution lines. Perhaps this is the reason: every post is checked by ultrasonic methods for defects before final assembly.



Operator looks for defect indication made by small pulsation in square-wave area. He seldom finds it.



Ultrasonic equipment testing O-B solid, four-petticoated line posts for defects in the porcelain.



Every O-B solid-porcelain line post is subjected to the ultrasonic test before delivery for distribution service.

SYSTEM approach to insulator-hardware design gives you another EHV "Extra"

O-B Insulator-Hardware combinations designed, manufactured, and tested to fit and perform like a "system"

At O-B the transmission engineer finds more than just individual components for sale in an assembly. Here he gets a complete, interdependent assembly -- an insulator-hardware *system* -- to support and protect his new EHV line. O-B calls its assembly a "system" because that's just what it is. Physically, mechanically, and electrically, each component fits naturally and performs interdependently with the remaining "system" elements. What does this mean? Let's examine each facet.

First, development of your insulator-hardware system design is the responsibility of one engineer. He works with other men who know the performance characteristics of the individual components and has a rich experience reservoir himself. Problems encountered during design development are worked out through counsel with his fellow development engineers and tests in the O-B High Voltage Laboratory.

Design development begins with analysis of your new line's specifications and performance requirements. Locations of the suspension "system's" load center is the first step, and requires resolution of anticipated mechanical cycling induced by wind, ice, or fault-current loads. To achieve optimum reaction to applied forces and maintain "system" stability, the O-B development engineer places the insulator string attachment point on the yoke as close to the load center as possible. Design principles established by O-B engineers and covered by U. S. patents permit this *stabilized* yoke design. With multiple conductor bundles, electrical performance improves substantially when the suspension string attaches closer to the load center. Lower insulator units enter or approach the shielding "cage" of the bundled conductors and render auxiliary control devices unnecessary. Bulky control rings may be eliminated, along with their material, installation, and maintenance costs.

Insulator and hardware manufacturing demonstrates more of O-B's "system" approach. We control the manufacturing operation for each component. Large diverse facilities enable the development engineer to select the correct material and method for manufacturing -- including casting, forging, flamecutting, welding, and machining; using alloys of iron, aluminum, bronze, or steel. Analysis of your predetermined performance characteristics also lets the O-B engineer select the correct size, strength, and type insulation to support the "system."

When prototype assemblies are manufactured, a complete insulator-hardware system is constructed by the O-B development engineer. Checking and rechecking fit and position reduce assembly problems during the actual line building. Each O-B component fits into the complete "system" -- O-B's principle of "made together to work together" put into practice.

Hardware components acquired from separate suppliers may fit physically under normal conditions, but during the abnormal disturbances induced on a line, one component may "lock-up" or bind against another. O-B's integrated insulator-hardware system offers you protection against failure during mechanical cycling. After proper fit is assured on the prototype assembly, O-B engineers check the "system's" reactions to line transients to assure the calculated performance traits.

Testing continues in the O-B Mechanical Laboratory where basic strengths are established for each component. Results confirm the

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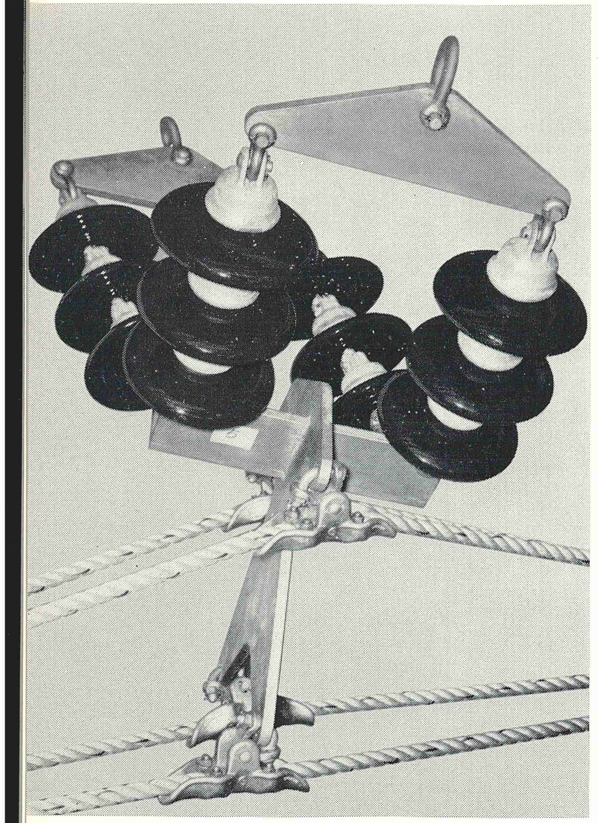
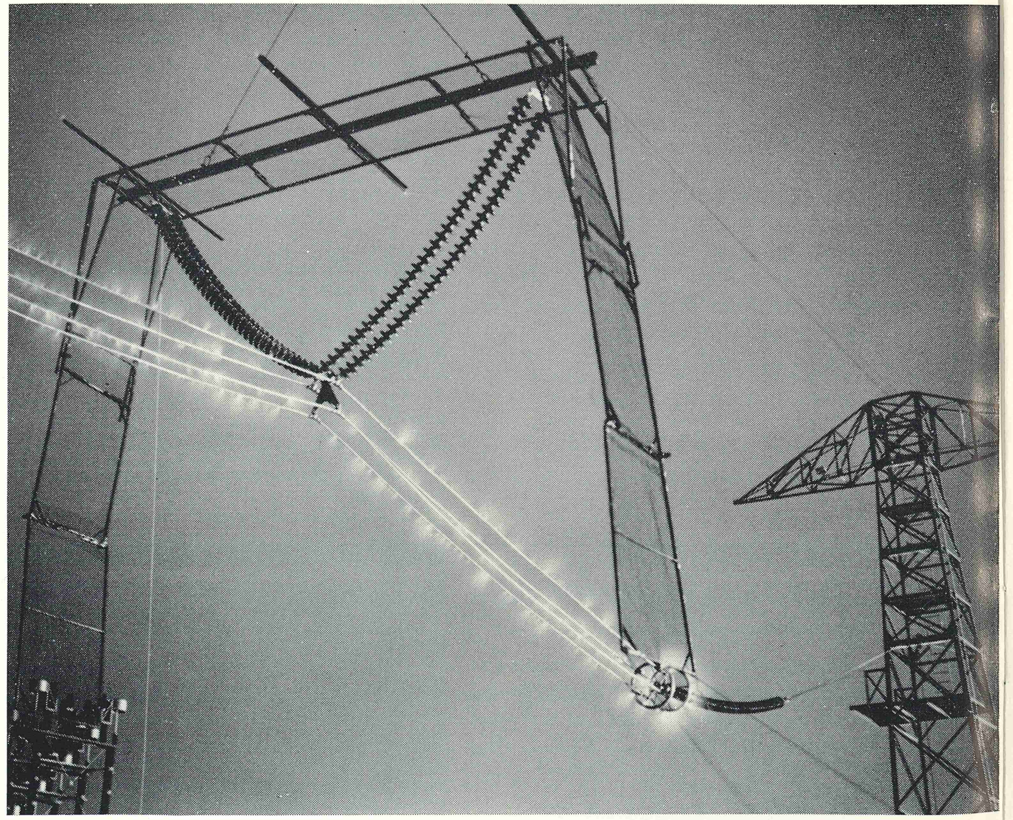
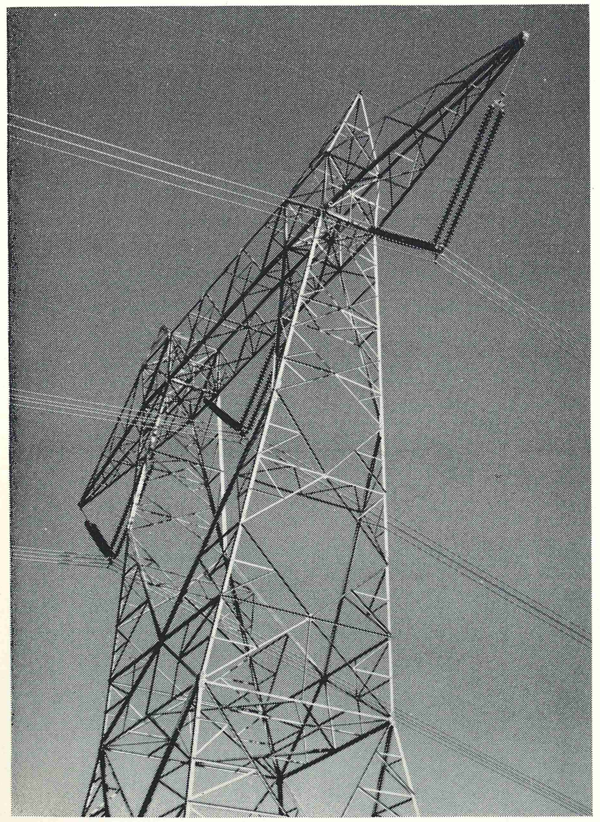
O-B development engineers check and recheck fit and position of each component, including reaction to applied transient forces to assure calculated performance traits are present at extreme positions.



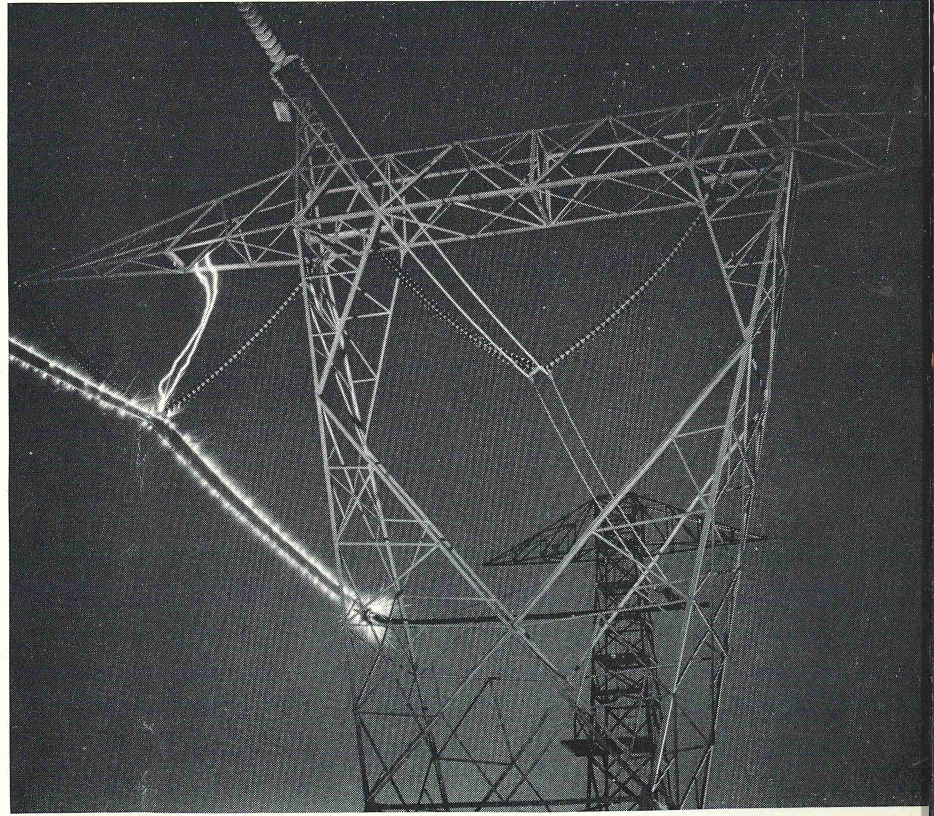
Critical electrical tests move outdoors in O-B's all-weather, High Voltage Laboratory where realistic data may be obtained for impulse, switching surge, and 60-cycle RIV and corona performance.



Transmission engineers raise line voltages and loads with every new network as utilities race to keep ahead of the compounding growth in power demands. Here is just one circuit of a three-circuit, 735-kv, 5-million-kw network supported by an O-B insulator-hardware **system** design.



O-B's High Voltage Laboratory permits preliminary research and final design certification testing on full-scale towers similar to this 500-kv structure.



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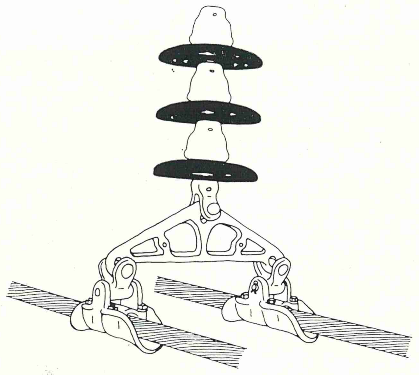
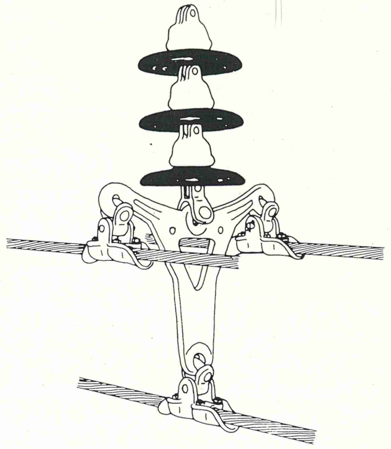
final assembly's strength and adequacy. After each component passes the required mechanical tests, the critical electrical examinations begin in the High Voltage Laboratory.

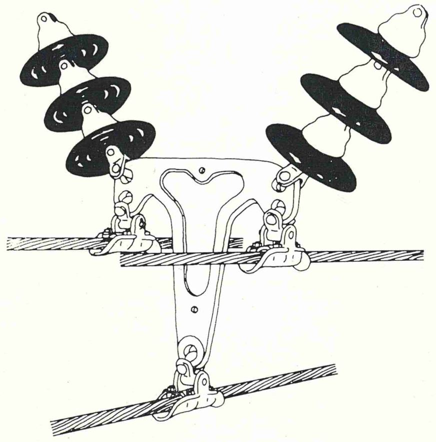
Electrical testing of the modern EHV insulator-hardware system moves outdoors -- partly because a roof can't contain the high potentials, and partly because outdoor testing gives more realistic performance data. The O-B High Voltage Laboratory's outdoor area permits construction of full-scale prototypes. If you wish, a complete tower top may be erected to test your insulator-hardware design. A four-million-volt impulse generator, three 750-kv transformers, a new voltage divider and wave shaper, and precision regulatory equipment operated by trained and experienced laboratory technicians assure you accurate data from switching surge, impulse, RIV, and 60-cycle overvoltage performance tests. O-B can also assist with your preliminary research and final tower design certification.

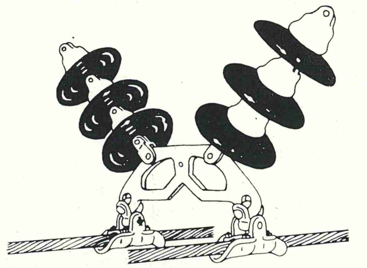
When prototype assemblies have passed all the required physical, mechanical, and electrical tests, the final design is approved. Complete performance data are presented to you for approval. Then, production begins. During manufacturing, each component receives multiple inspection and testing to assure faithful design reproduction.

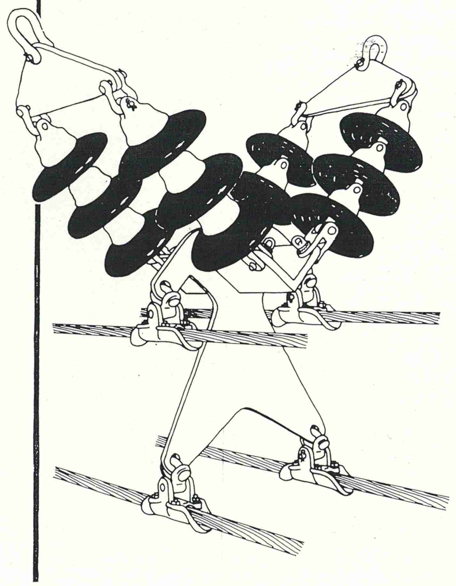
We admit the preceding processes seem rigorous and time consuming, but we consider them necessary. When the first O-B insulator-hardware system goes up it fits together naturally and is ready to do its job. It's just as ready when the last assembly is installed and the line energized. Ten years from now when perhaps we've entered a new era of EHV transmission, it will still be there, performing like the system it was designed to be. Learn more about the extras in EHV at Ohio Brass. Contact your O-B district manager and ask him about a complete insulator-hardware *system* for your new line. He will be glad to help during the planning and construction stages.











Whether you choose two, three, four, or more conductors suspended from V-string and (or) vertical strings for your basic configuration, you get patented stabilized yoke design and system-like performance from a complete O-B insulator-hardware system.

Holan builds strong lower arms on Bronco elbows

Internal-reinforcing angles disperse loading over length of arm, increase strength with minimum additional weight

The lower arm of today's aerial device must withstand heavy loading and severe twisting action. It all adds up to the need for reaching higher . . . lifting greater loads . . . winching . . . and even digging.

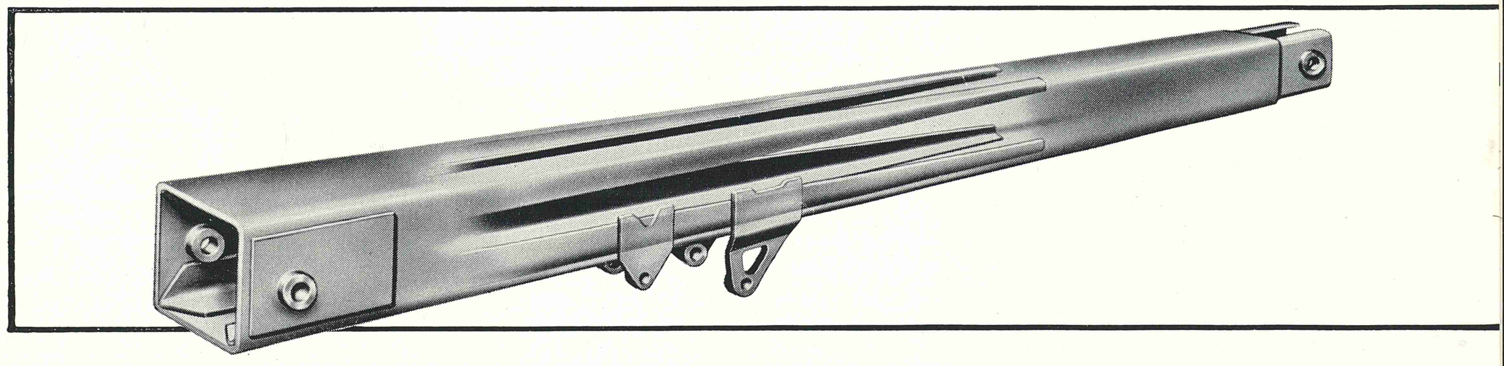
Quick and easy methods of strengthening the lower arm -- "heavying up" the gauge, or welding unsightly plates in areas of greatest stress -- are only partial and undesirable afterthoughts. You add dead weight, which cuts the ultimate load capacity and detracts from the unit's appearance.

Holan's solution is simple and unique in the industry: internal angle clips are welded into all four corners of the tubular arm. Length and taper of the clips depend on the arm length and are usually two thirds of arm length. Section dimensions of the angle clips are unchanged from the lower end of the arm to the rod-eye connection for the main lift cylinder. They are tapered from that point for a uniform stress pattern toward the "elbow" joint.

This method of reinforcing assures a uniformly stressed beam i. e., loading is evenly distributed along the length of the arm. In this manner, shock loading is absorbed over the entire structure and not at critical points. Normally, heaviest loading stresses would occur from the lower end of the arm to the main-lift cylinder connection. Thus, there is more reinforcing at this point, less beyond the point, and a constant design stress value along the length of the arm.

In addition to the high strength-to-weight ratio, the reinforcing angles also increase torsional strength and support of the lateral walls in the tubular structure. This reduces the probability of lateral wall buckling and "oil canning."

The lower arms of all Holan Bronco Elbows are built in this manner. That's why you can use them for derrick applications -- even mount diggers on some -- without costly, additional "beefing up." For more information, write: Holan Division, The Ohio Brass Company, 4100 West 150th Street, Cleveland, Ohio 44135.



X-ray view of Bronco-88 lower arm showing tapered angle clips welded into the four corners. This provides a uniform stress beam for high energy absorption and a high strength-to-weight ratio.

Dig holes with Holan's 5300-1 Earth Borer mounted on lower arm of Bronco elbow. Digger develops up to 7000 foot-pounds of torque. ▶

◀ Set poles in the holes you've dug with Holan's Bronco-88 elbow. The first aerial device in the industry designed from the outriggers up for safe and dependable materials handling.

Made to take lightning's punch

GraybaR
QUALITY
SINCE 1869
Distributed by
GraybaR
ELECTRIC COMPANY

O-B distribution pintype designs are proved on ultra-steep-wave tests; production units resist lightning damage in service

During the history of electrical distribution, the pintype insulator failures have been responsible for many distribution outages. The biggest cause of pintype failure in service has been lightning. Beyond the idea of disrupted service, an insulator punctured by lightning can be extremely difficult to locate, and the cost of finding and replacing it is likely to be several hundred times the cost of the insulator itself.

Faced with this dilemma, distribution men historically have been on the lookout for a solution to the problem. Installation of a *better* pintype seems to be the only real answer for utilities.

But how to approach it? What should be considered? One important fact is known: Laboratory tests have proved the industry's standard 1½ x 40 microsecond test waves do not approach the severity of lightning. Most utilities looked for answers from manufacturers.

At least two decades ago, with a full understanding of the problem, Ohio Brass began to assemble the factors required to meet these needs. O-B research into the nature of lightning proved to be fruitful. An ultra-steep-wave generator was built to test, among other things, O-B pintype designs based on the new knowledge of lightning. A manufacturing philosophy obligated O-B personnel to develop the best pintype possible for distribution service. The process of "pintype perfection" began.

Through many years of continuing research, designing, testing, and improving the manufacturing

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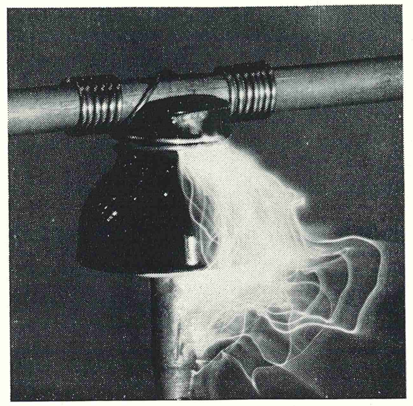
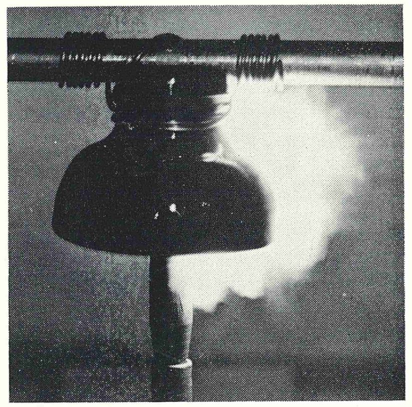
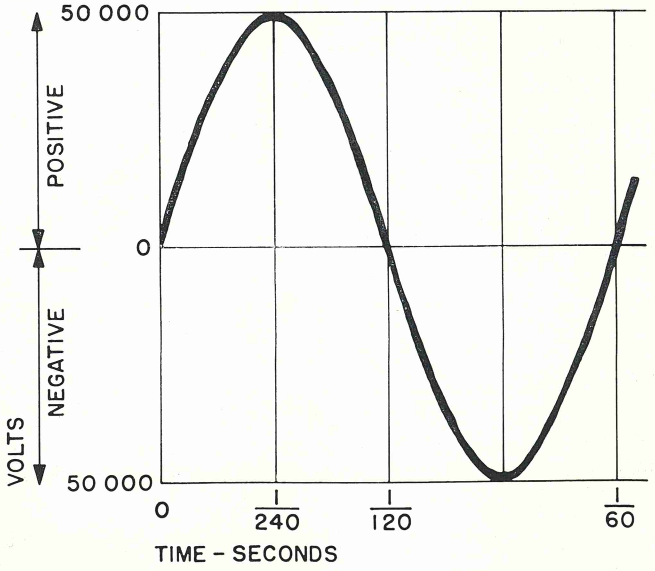


Dry 60-cycle flashover of a Number 38148 pintype insulator for 13.2-kv service. Flashover discharge occurred at 65 kv R. M. S.

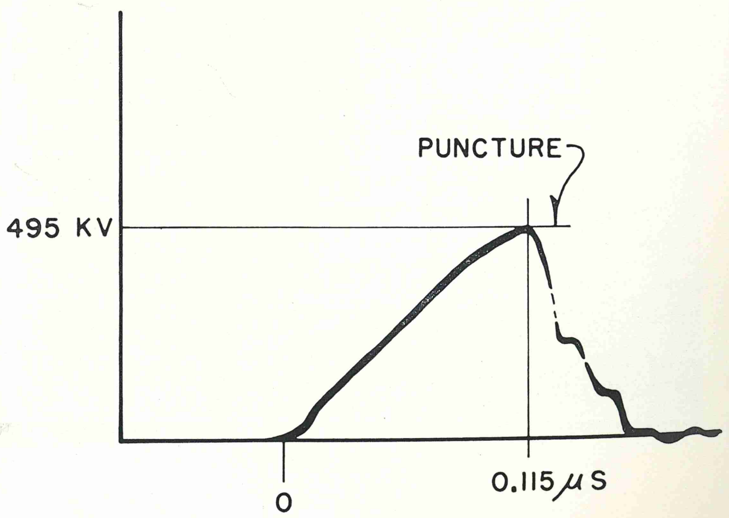


Number 38148 pintype insulator on steep-wave impulse test. Flashover discharge happened in one microsecond at 400 kv. Before flashover relief, pintype took six times the flashover stress of regular 60-cycle voltage.

Sine wave of 50,000-volt crest magnitude on 60 cycle. Voltage rises from zero to maximum positive polarity, and swings back to zero to maximum negative polarity, and returns to zero -- all in 1/60 second. Peak voltage occurs in 1/240 second.



Typical oscillogram of linearly rising voltage wave as it is chopped by puncture of the test specimen.



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processes, Ohio Brass consistently produced dependable lightning-resistant characteristics in its low-voltage pintype insulators.

Key to the manufacturing of a line of pintype insulators which are *all* alike and are *all* reliable is proof that the design exceeds the requirements of the ultra-steep-wave tests. Many utilities are calling for more rigid steep-wave-front tests for insulators before including the pintype in the list of acceptable materials for purchase.

For an appreciation of what this type of testing consists of, we must consider the devastating speed and intensity of the rate of rise of lightning voltage, plus the delay imposed by the ionization of air. These factors explain the stress impressed on a small pintype when lightning strikes.

To illustrate: The Ohio Brass Number 38148 pintype for primary distribution up to 13.2 kv has a dry, 60-cycle flashover rating of 65 kv. At 60 cycles, the ionization lag of air is negligible. But under ultra-steep-wave impulse, Number 38148 may not flash over until 400 kv, or about 4½ times its 60-cycle crest rating. This demonstrates the ionization lag; a conductive air path did not have time to form before 400,000 volts had built up on the porcelain. It all hinges entirely on a matter of time. The air reacts to overstress quickly, but the ionization of air does require some measure of time. O-B pintypes offer this necessary measure of time. When the air surrounding a low-voltage O-B pintype insulator is ionized in one tenth of a microsecond, or faster, lightning voltage impressed on the insulator might reach as much as 400,000 volts before relief by the flashover. In these microscopic moments of electrical time, pintype insulators win or lose -- they withstand lightning's assault or they puncture.

Through decades of rewarding research, O-B pintypes have been designed, tested, and manufactured to withstand *and win*. At no extra cost, you can put them to work for you on your distribution system.

THOREX® MULTIRESTER

Buyer's guide for distribution class lightning arresters

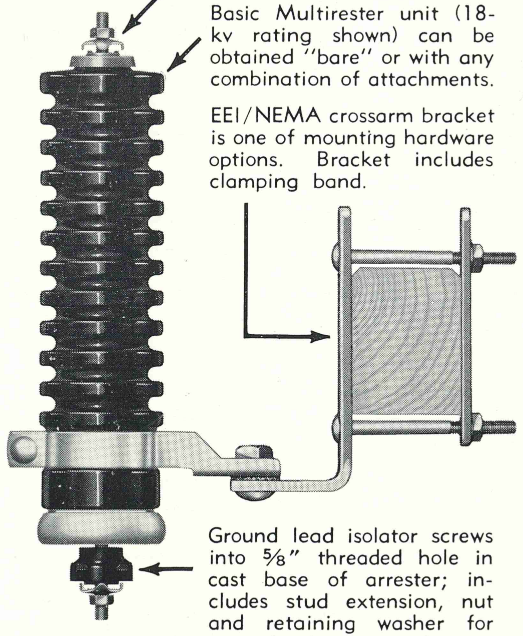
Itemized consideration of physical, electrical, and installation qualifications emphasizes Multirester advantages.

Value analysis of distribution class lightning arresters involves the comparison of so many different desirable qualifications that the most effective listing of common requirements can best be made in the form of a Buyer's Guide.

Tabulation of factors which electric utilities have established as influencing the selection of distribution arresters clearly delineates many Multirester advantages. These features add important benefits to Multirester's field performance record for unexcelled dependability and consistent operation.

No other arrester in Multirester's class provides as great an opportunity for improved protective levels for line and equipment applications and for significant savings from the inherent economies associated with ordering conveniences, stocking simplification and field installation versatility.

(Continued on next page)



Typical line terminal group consists of ⅜" stud, nut and retaining washer.

Basic Multirester unit (18-kv rating shown) can be obtained "bare" or with any combination of attachments.

EEI/NEMA crossarm bracket is one of mounting hardware options. Bracket includes clamping band.

Ground lead isolator screws into ⅝" threaded hole in cast base of arrester; includes stud extension, nut and retaining washer for ground wire connection.

EXAMPLE OF SIMPLE ORDERING PROCEDURE WHICH APPLIES TO ALL MULTIRESTERS

Specifications in Catalog 43 assign catalog number 210 107 to basic 18-kv Multirester unit.

Attachments are specified from Catalog 43 by using code 7 A B C:

Line terminal group A = 2

EEI / NEMA bracket and hanger B = 2

Ground lead isolator C = 4

Single catalog number for typical Multirester illustrated is 210 107-7224.

THOREX® MULTIRESTER

Buyer's guide for distribution class lightning arresters

PHYSICAL CHARACTERISTICS		MULTIRESTER QUALIFICATIONS
1. Arrester housing must be effectively and permanently sealed to exclude all moisture and air-borne contaminants.	✓	Multiresters have industry's most effective and enduring sealing system. Calibrated compression of protected neoprene gaskets automatically compensates for temperature changes and aging. Seal of every Multirester shipped must pass sensitive instrumentation test and no field difficulties are known to have been caused by seal deterioration.
2. Arrester must have rugged construction capable of withstanding severe weathering and rough handling without damage to its housing, terminals, or internal structure or components.	✓	Multirester has wet process porcelain housing with strong, modified skirts and cemented malleable iron base. Exposed metal parts are noncorrosive finish. Spring-compressed assembly of Multigap and valve blocks cannot shift position inside housing.
3. Arrester must be compact in size and light in weight to facilitate mounting and installation, and to minimize loading on hanger brackets and crossarms.	✓	Multiresters save space and weight in their internal construction by using matched and tested kiln-fired valve blocks working in conjunction with efficient series Multigap. Consequently, Multiresters are shorter in length than other distribution arresters of the same kv rating.
4. Arrester appearance must conform with that of other distribution equipment. Terminals, leads, and other accessory equipment should be arranged to simplify pole top connections.	✓	Multiresters are available in either brown or skytone glaze. Their diameter to length proportions are similar to those of post insulators. Terminal studs located at top and bottom facilitate line and ground connections. Terminals accommodate all normal conductor sizes.
5. Arrester must have permanent identification which includes kv rating, external gap spacing and catalog number.	✓	Multirester identification information is sandblasted into the glaze at the base of the arrester and cannot wear or fade.
6. When received, arrester should be ready for immediate installation and use.	✓	Mounting brackets are securely fastened in the arrester shipping package; all other optional attachments are completely assembled to Multiresters before shipment from the factory.
7. Arrester accessory equipment such as terminal studs, nuts, and retaining washers should be standard commercial items readily available from maintenance stock bins, or from local hardware suppliers.	✓	Multirester terminal parts consist of ⅜" and ⅝" studs with standard threads and corresponding nuts and retaining washers, all commercially available. Multiresters can be ordered without including any of these parts if more convenient to user.

ELECTRICAL CHARACTERISTICS		MULTIRESTER QUALIFICATIONS
1. Arrester must meet all present ASA standard test specifications for distribution class lightning arresters.	✓	Laboratory tests of Multiresters prove performance which significantly exceeds ASA specifications. O-B tests are made for IR discharge voltage, duty cycle, and discharge capacity including long duration low current. Multiresters are capable of repeated sparkover and surge discharge operation without loss of protective characteristics or discernible deterioration of internal components.
2. Arresters must be permanently free of RIV, regardless of duties or location of specific application, or of treatment to which arrester has been subjected in mounting or transit.	✓	Production and laboratory tests of Multiresters are arranged to assure a design completely free from RIV. Sturdiness of individual components and of construction of Multirester operating circuit eliminates any possibility of introducing field RIV problems due to rough handling in shipment or installation.
3. Arresters should be available in a full line of voltage ratings for application on all distribution circuits with nominal voltages of from 3 through 46 kv.	✓	The superior protective features of the Thorex Multirester design are provided in all voltage ratings from 3 through 37 kv, thereby providing an opportunity for standardization of arrester application practices and the stocking advantages derived from interchangeability of mounting and accessory equipment.

ELECTRICAL CHARACTERISTICS		MULTIRESTER QUALIFICATIONS
4. Arrester sparkover response coordinated with application requirements.	✓	Multiresters provide a low consistent sparkover level for all normal applications; distinguishes and makes available special RM arrester series for low sparkover response needed to protect equipment having dry insulation and unusually critical machinery or apparatus.
5. Arresters can be installed at any location on the distribution circuit.	✓	Interrupting ability of Multiresters is not dependent on either line impedance or short circuit current capacity; Multirester can be located on end, middle or source of distribution circuits. Functions equally well on the pole top as close-coupled to the distribution transformer.
6. Arrester housing must not flashover.	✓	Leakage distance of porcelain housings of O-B Multiresters effectively prevents flashover in accordance with the same design criteria as other porcelain insulators on the circuit.
7. Arrester operation should be noiseless.	✓	Multiresters spark over and discharge overvoltage surges without perceptible noise or flashes.

INSTALLATION ADAPTABILITY		MULTIRESTER QUALIFICATIONS
1. Terminal parts, mounting brackets and other accessory equipment required for specific distribution arrester applications should be entirely optional.	✓	O-B's unique code system of specifying Multiresters permits selection of any combination of terminal, mounting and accessory equipment with a single order number. Multiresters can also be furnished completely bare, providing a price advantage wherever hardware items are in utility stock or can be purchased more economically from a local supplier.
2. Arrester design should be conveniently adaptable to various mounting attachments for locating arrester on crossarms, pole tops, flat surfaces and in combination with other equipment.	✓	Completely interchangeable basic Multirester can be installed by use of inexpensive brackets or angles which provide a wide range of option. Most common arrangement uses clamping band to encircle body of arrester, but surface mounting simply requires a ⅝" through bolt inserted in the base casting of the arrester.
3. Simple and inexpensive brackets should be available to simplify the installation of new arresters directly on transformer tanks of any manufacture.	✓	Many styles of brackets for tank-mounting Multiresters are available. Simplification of arrester replacement on transformers is accomplished by a bracket adapter kit from which the proper spacing and location of the mounting angle can be selected.
4. A choice of antilockout devices designed specifically for operation on the arrester ordered should be available as an optional accessory.	✓	Multiresters from 3 through 20 kv can be ordered with detachable external spark gap assembly. Multiresters of all voltage ratings can be ordered with a precision-actuated ground lead isolator which automatically disconnects the arrester ground whenever fault current exceeds the isolator calibration point.
5. Mounting position of arrester should not affect its sparkover response, discharge operation or other protective characteristics.	✓	Multiresters can be mounted in either horizontal or vertical position, or at any included angle without change in arrester protective capabilities.
6. Catalog and descriptive information should describe arrester characteristics and fully explain optional attachments.	✓	Multirester Catalog 43 lists all ratings of distribution class arresters available, together with their electrical and mechanical specifications. In addition, a simple catalog code system facilitates specifying optional equipment, including terminal parts, mounting brackets, transformer change-over brackets and others. O-B Publication 1575-H describes and illustrates the function of distribution class lightning arresters.

Successful Cornell Field Trials prove capabilities of 345-kv underground systems

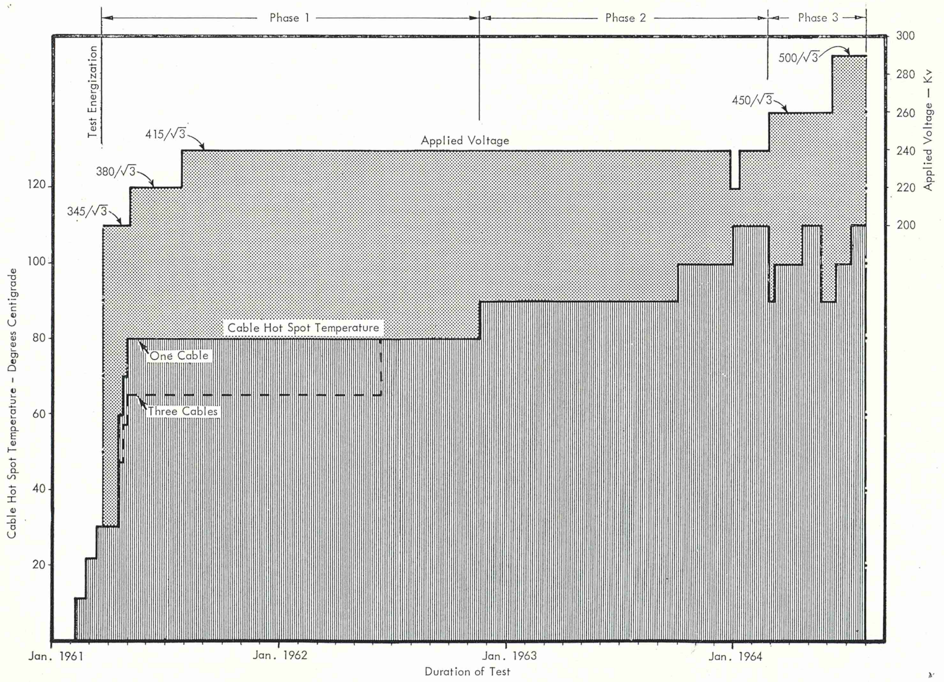
Dividends from cooperative research project include significant improvements in EHV potheads

Findings of the Joint AEIC/EEI/Manufacturers Committee concerning the feasibility of 345-kv underground transmission were formally reported by L. I. Komives of The Detroit Edison Company, chairman of the committee, at the June, 1965, meeting of the IEEE Power Group in Detroit. Integrated into the account of the eminently successful test results were several important developments in EHV pothead design, which were instituted under the severe working conditions imposed during the test schedule and which have now been incorporated into standard construction.

The Cornell test was originally proposed in 1953 as a major cooperative field research project to investigate the aspects of moving large blocks of power by 345-kv underground cable. Arrangements for the test site and technical personnel, preparation of the test facilities, and development of cables, potheads, and accessory equipment required almost eight years for completion. Actual tests of the installed underground systems began in February, 1961, and were concluded in August, 1964. The test results have now been documented by the Joint Committee responsible for the project and by each of the participating manufacturers in supplementary reports on the comprehensive evaluation of effects on the equipment submitted.

The Cornell project was the first large scale American EHV testing program undertaken by a group of investor-owned electric power companies in cooperation with their suppliers and conducted by a large university. Principal suppliers were the four cable manufacturers, Anaconda, General Cable, Okonite, and Phelps Dodge, and the two pothead manufacturers, G & W and Ohio Brass. In addition, Anaconda supplied a single pothead made by Pirelli of Italy, and various other suppliers were responsible for control and energization equipment.

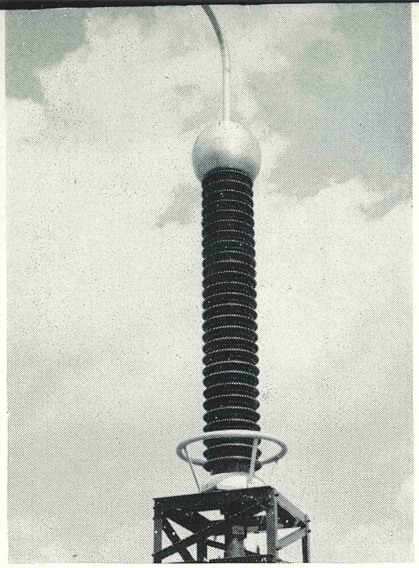
Figure 1—Voltage and temperature values for Cornell Cable Research Project. Hot-spot temperature of cable determines current loading.



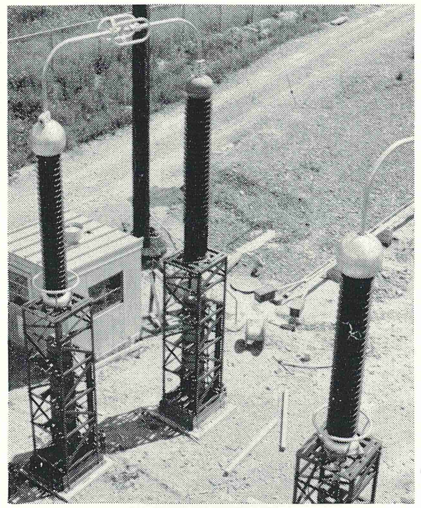
The 1965 IEEE paper states that the Committee has concluded that the results of three years of field testing under typical and emergency conditions clearly demonstrate the ability of underground cable systems to carry blocks of power as large as 500 mva over relatively long distances at voltages of 345 or 400 kv. The report further indicates that operating conditions currently applicable to lower voltage transmission cables were found suitable for transmission at these higher voltages.

The Cornell test project had three major test phases. First phase subjected the cable systems to overvoltage and to current loading simulating normal operating conditions. Second phase continued the overvoltage and increased the current loading to a level approximating emergency operating conditions. Third phase investigated the stability of cable systems at even higher voltages and temperature. The major testing sequences of the Cornell project are diagrammed in Figure 1, where the applicable operating conditions are charted against an abscissa of time to indicate the duration and values of the applied overvoltages and to indicate how thermocouple readings of hot spot temperature were related to current loading.

The Cornell test project was conceived as a field trial of installed systems to explore compatibility of available 345-kv underground transmission cables, joints, and terminations. Cooperating manufacturers were thus given an excellent opportunity to observe and detect installation difficulties in advance of large scale service applications, and to alter or modify equipment in accordance with requirements for system coordination. This procedure returned important dividends to utilities contemplating underground EHV installations, since several significant refinements were incorporated into the trial equipment early enough in the 42-month test schedule to prove that a high order of reliability could be assured. Dielectric-loss tests demonstrated conclusively that a commercial underground EHV line can reach an insulation power factor below 0.25 per cent, thereby satisfying an original objective of the trials.



Cornell test included periods of severe overvoltage and loading characteristic of emergency conditions. Post-test examination of O-B potheads revealed no unstable condition in the internal insulating structure.

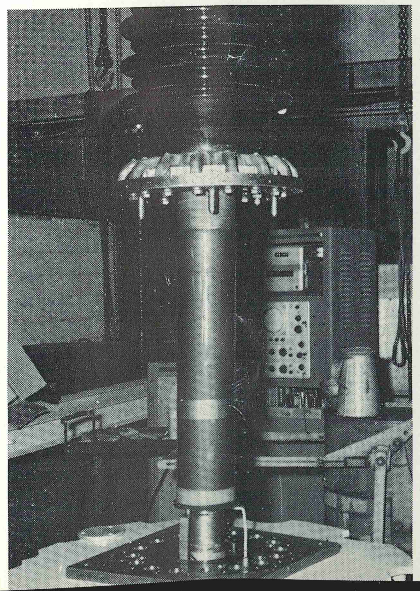


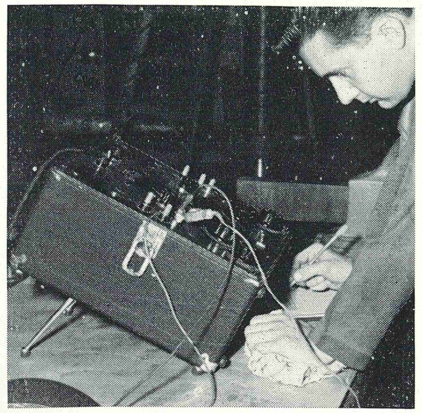
O-B 345-kv potheads were used at the Cornell test site to terminate one end of each of the four types of underground cable under test.

A detailed accounting of the installation and operation of the Cornell underground test cable systems is contained in the 1965 continuation of Transaction Paper T-129. The Joint Committee's technical analysis explains the advisability of modifications made by the suppliers and indicates that subsequent performance fulfilled all test requirements.

System operating stability attained is further substantiated by the supplementary papers presented by each of the cooperating manufacturers, in which post-trial examinations of the equipment are thoroughly discussed. In the Ohio Brass paper on this subject, descriptive details are given which interpret the laboratory analysis of the effects of the severe test program on the internal components of the capacitor potheads. In examining the returned potheads, the build-up rolls were unwound and carefully inspected for evidence of carbonization. Individual capacitors were removed from the interior of the porcelain housing and subjected to exhaustive tests. O-B's paper evaluates each of the tests made on the dismantled pothead components and on the basis of this comprehensive investigation concludes that no evidence of any unstable condition could be found and that no measurable deterioration of the dielectric of the capacitor stacks had occurred despite the severity of the tests. Under such conditions the Cornell tests prove that potheads incorporating O-B's capacitance grading system and factory-wound foil stress cone can effectively terminate EHV cables with the high stress levels used in the trials.

Following completion of the Cornell trials a rigorous inspection was made of the build-up roll and stress cone of the capacitor potheads.





Capacitors were removed from support tube and subjected to series of inspection and measurements. Capacitance and dissipation factor were precisely checked on laboratory bridge circuit.

Ohio Brass is proud and appreciative of its opportunity to participate in the cooperatively sponsored Cornell Cable Research Project. Particularly significant was the fact that O-B capacitor potheads were installed on each of the four types of underground cable under test and that efficiencies of the O-B 345-kv pothead design could be checked out for a variety of installation requirements. Furthermore, the Cornell tests were directly responsible for incorporating important refinements in the design of individual system components, such as the potheads, prior to their commercial sale and installation. Advantages of O-B potheads with full capacitor grading and factory-wound foil stress cone were fully confirmed under actual operating conditions at rated and beyond rated capacities. Substantial advances in user assurance of unimpaired system reliability of EHV cable installations were accomplished through the results of the Cornell project.

OHIO BRASS MANAGEMENT REPORT

Why we believe in one-color rainbows in '65

BY ROGER A. BLACK
PRESIDENT, OHIO BRASS COMPANY

What could have become a serious problem now seems well on the route to solution thanks to decisive action by the Transmission & Distribution Committee of EEI. Also contributing to the constructive solution are important user groups such as Southeastern Electric Exchange.

AS YOU PROBABLY KNOW, the EEI committee has recommended Munsell No. 5 BG 7.0/0.4 as the standard color for insulators and other overhead materials. Acting for the manufacturers, NEMA has instructed its representative to ASA to vote for the new EEI color as a standard color in Code Z-55.1 covering American standard gray finishes for industrial apparatus and equipment. At Ohio Brass we will soon offer many products in Munsell 5 BG 7.0/0.4 and hope it gains widespread acceptance among our customers.

THUS WE CAN ANTICIPATE an end to the nightmare that plagued the dreams of manufacturers in recent months — a nightmare that had every utility asking for a special color. As the colors multiplied into hundreds of shades and hues, we shuddered at the chaos that would result in the planning and cost of manufacture. All the colors in the dream made a beautiful rainbow, but this time we wished the rainbow were all one color.

MUNSELL NO.
5 BG
7.0 / 0.4

ALSO CONTRIBUTING IMPORTANTLY to the clarification and definition of the new color was the system established by Albert Henry Munsell, an American portrait painter who died in 1918, long before we began worrying about insulator colors. Mr. Munsell measured three dimensions of color — hue, value, and chroma. He made it possible to express any particular color in precise terms and to differentiate it from other colors in the same general class.

THUS IN THE EEI recommendation for Munsell No. 5 BG 7.0/0.4, the first number (5) represents the hue of blue-green (BG), with hue being the quality to distinguish one color from another — green, blue, yellow. The second number (7.0) is the value, with value being the quality by which we distinguish a light color from a dark one; and (0.4) stands for chroma, or the strength of the color.

SO WE HAVE ARRIVED, or almost arrived, at Munsell No. 5 BG 7.0/0.4 . . . thanks to EEI, NEMA and Mr. Munsell's system.

738-H

OHIO BRASS COMPANY • MANSFIELD, OHIO
Canadian Ohio Brass Co. Ltd. • Niagara Falls, Ontario

OHIO BRASS

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Distribution lightning arrester "Buyer's Guide" (pages 11, 12, 13) reviews Multirester advantages.